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(54) Range meter for a camera

(57) A range-meter for a camera comprises light-projecting means (IR1, IR2, IR3, LS1) for sequentially projecting a plurality of beams in different directions; a plurality of light-receiving elements (PT1, PT2, PT3) each of which is arranged to receive reflected light from a subject (SB1 - SB3) which has been irradiated by one of the beams, each light-receiving element being arranged to provide an output signal corresponding to the position thereon at which the reflected light is received; arithmetic means (OP) for calculating from at least one output signal the distance to a desired subject; and means (DE) for determining which of the light-receiving elements has received the reflected light from the subject.

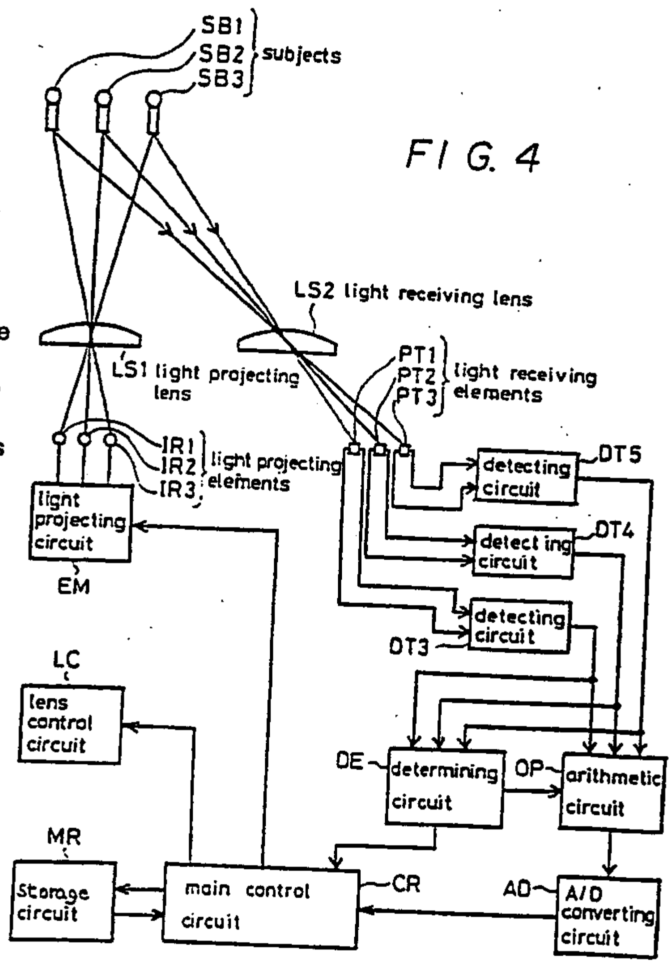

FIG. 4

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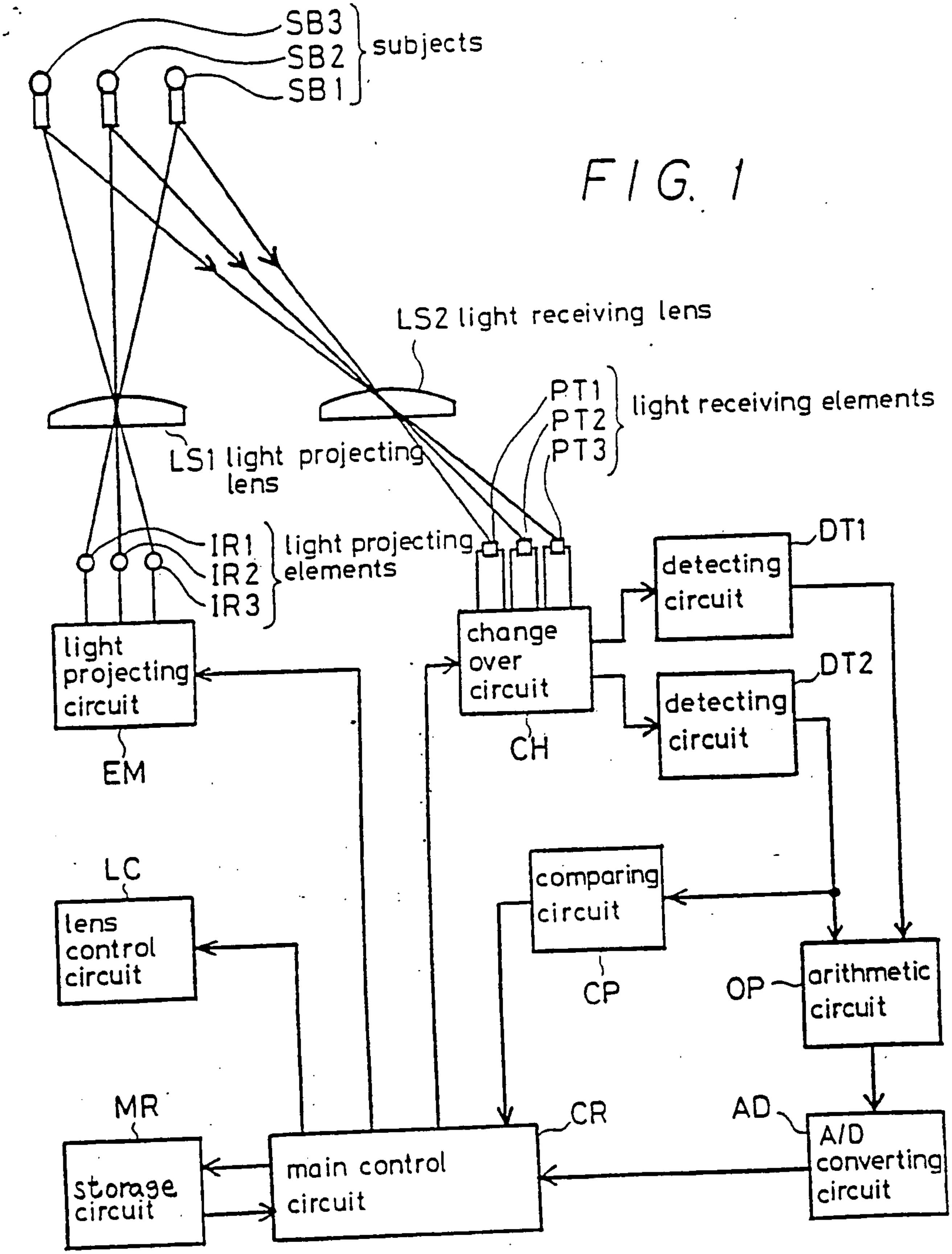
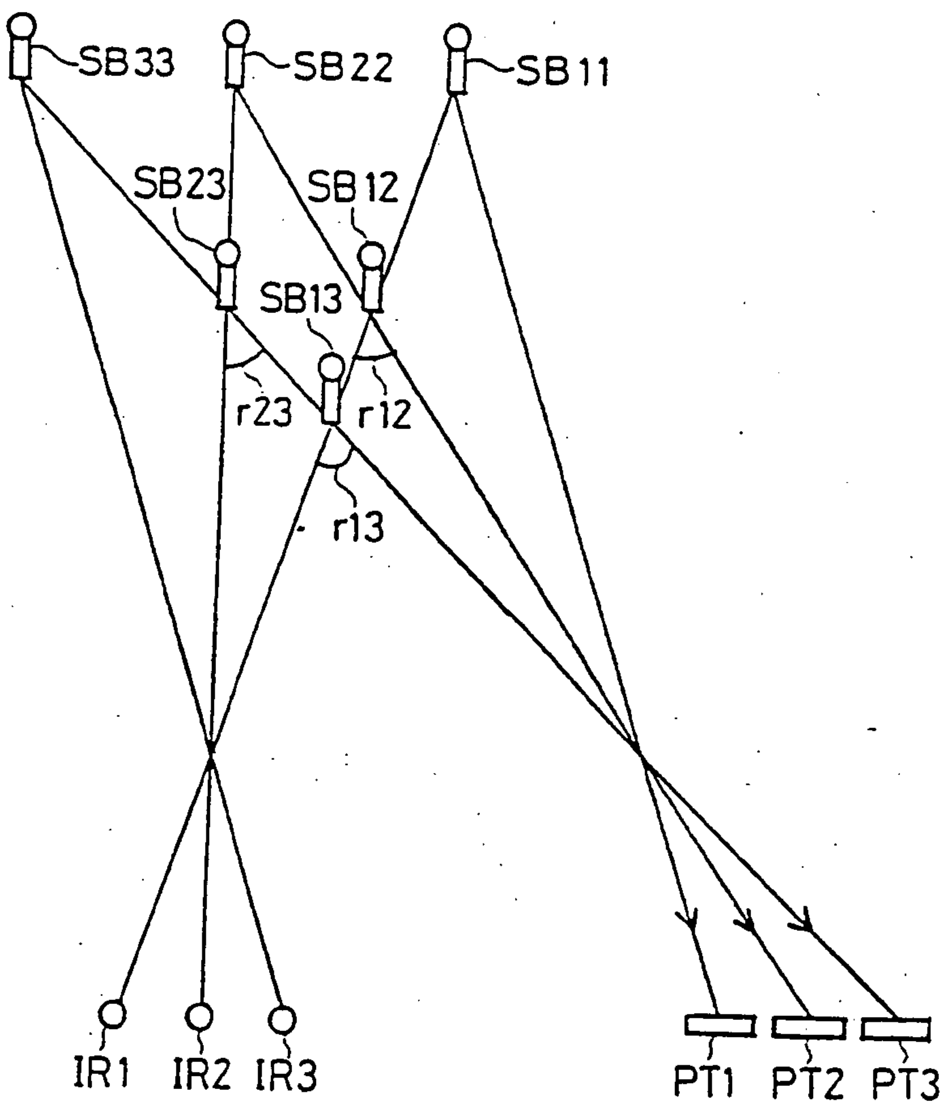


SB3
SB2
SB1
subjects
LS2 light receiving lens
PT1
PT2
PT3
light receiving elements
LS1 light projecting lens
IR1
IR2
IR3
light projecting elements
DT1
detecting circuit
DT2
detecting circuit
light projecting circuit
EM
change over circuit
CH
LC
lens control circuit
comparing circuit
CP
OP
arithmetic circuit
MR
storage circuit
main control circuit
CR
AD
A/D converting circuit

FIG. 1

FIG. 2


SB33
SB22
SB11
SB23
SB12
SB13
r23
r12
r13
IR1
IR2
IR3
PT1
PT2
PT3

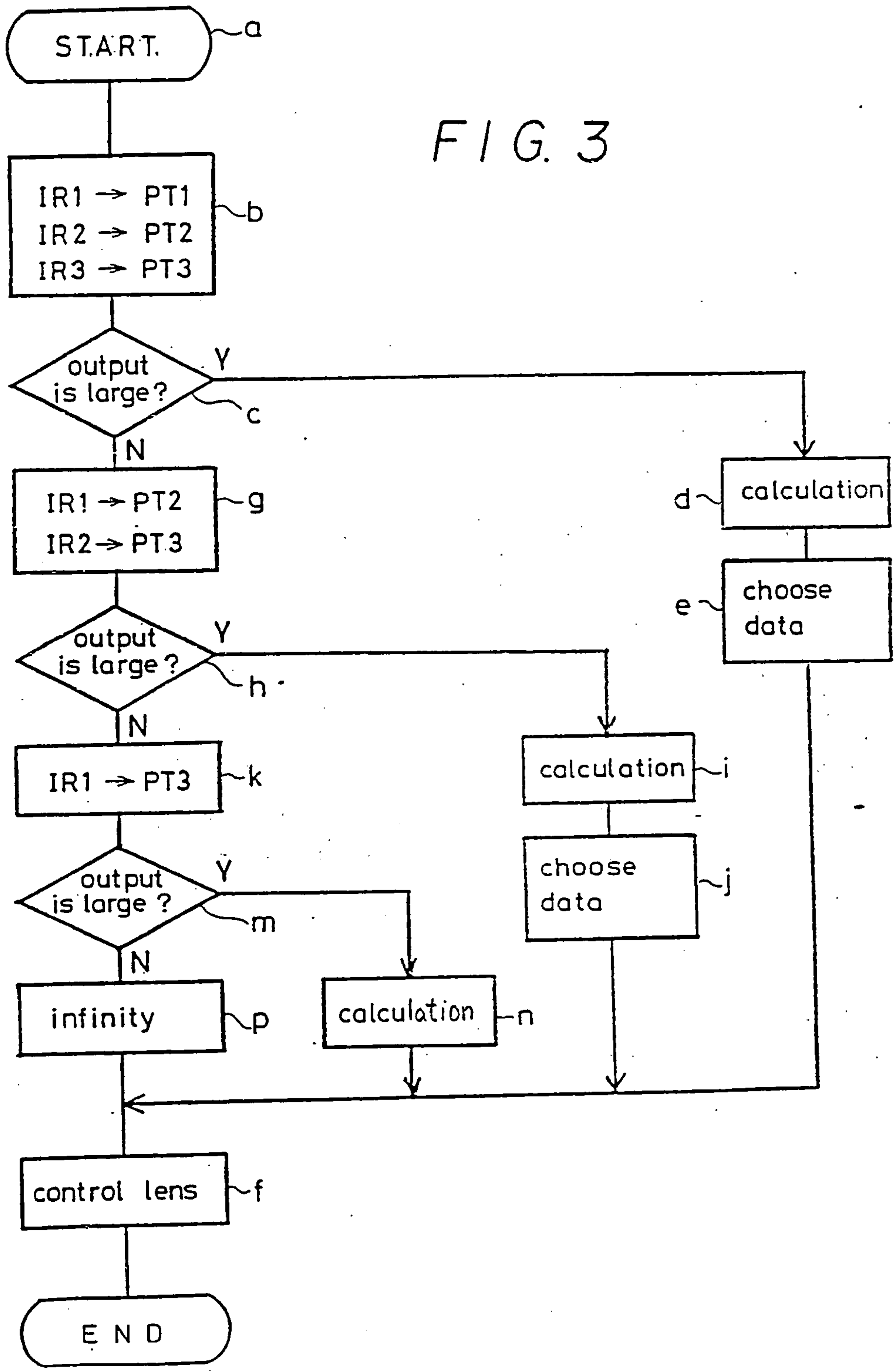

START.
a
IR1 → PT1
IR2 → PT2
IR3 → PT3
b
output is large?
c
Y
N
calculation
d
choose data
e
IR1 → PT2
IR2 → PT3
g
output is large?
h
Y
N
calculation
i
choose data
j
IR1 → PT3
k
output is large?
m
Y
N
infinity
p
calculation
n
control lens
f
END

FIG. 3

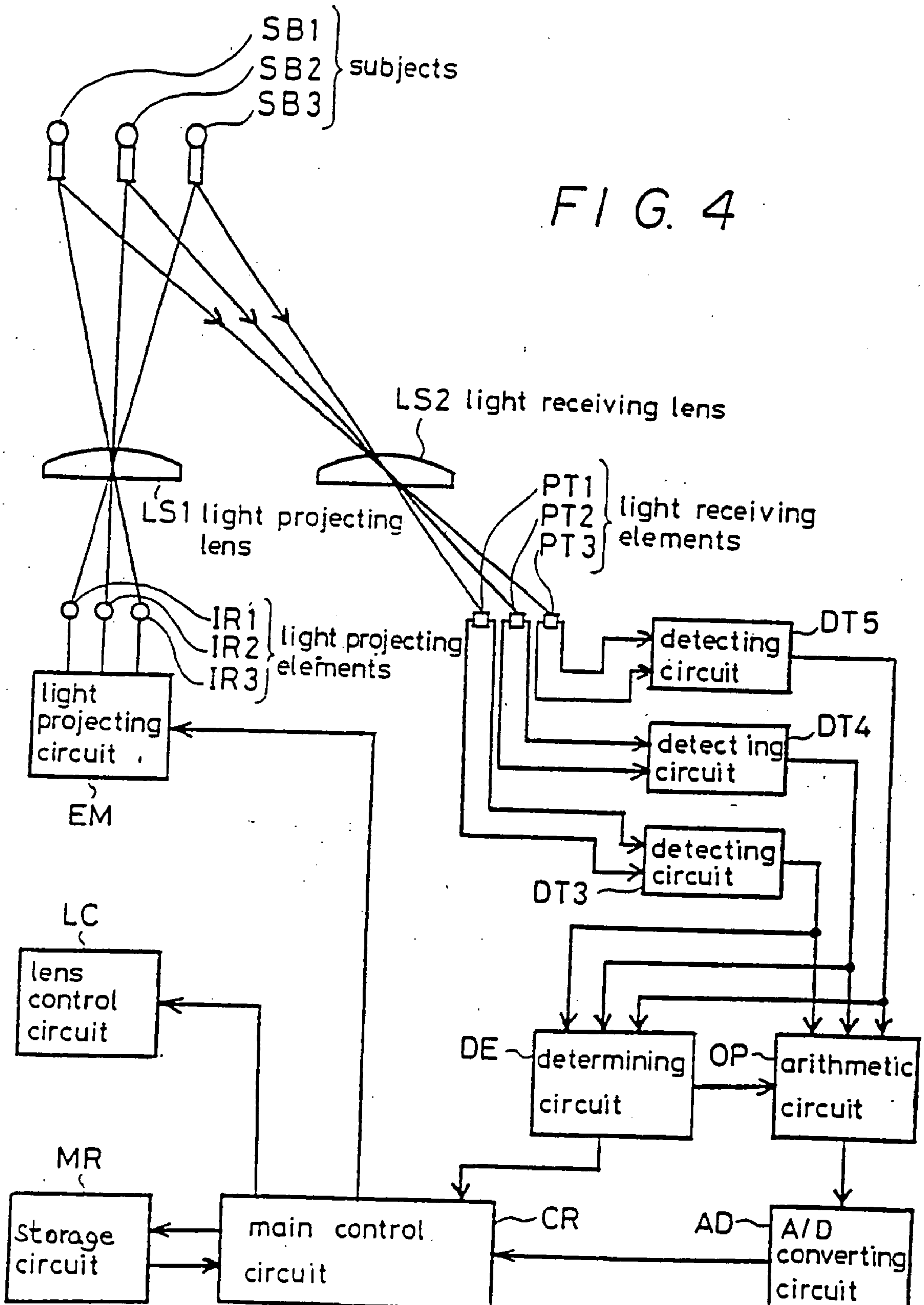

SB1
SB2
SB3
subjects
LS2 light receiving lens
LS1 light projecting lens
PT1
PT2
PT3
light receiving elements
IR1
IR2
IR3
light projecting elements
light projecting circuit
EM
detecting circuit
DT5
detect ing circuit
DT4
detecting circuit
DT3
LC
lens control circuit
DE
determining circuit
OP
arithmetic circuit
MR
storage circuit
main control circuit
CR
AD
A/D converting circuit

FIG. 4

"RANGE METER FOR A CAMERA"

This invention relates to a range meter for a camera.

In automatic focusing (AF type) cameras, the distance from the camera to a subject to be photographed is generally measured in accordance with a triangulation method. In this method, a far infrared beam is projected from a light-projecting element towards the subject, the reflected light from the subject is received by a light-receiving element, and the distance to the subject is calculated on the basis of the position on the light-receiving element of the light received from the subject.

In such a method as above wherein only a pair of light-projecting elements and light-receiving elements are used, however, it is difficult to obtain the distance correctly unless the subject is positioned at the centre of a viewfinder. Consequently, a so-called multi-automatic focusing (multi AF type) range meter is also known (see, for example, Japanese Patent Laid-Open Specification No. 62-223734) which uses a plurality of pairs of light-projecting elements and light-receiving elements. In this multi AF type range meter, the light-projecting elements and the light-receiving elements are disposed correspondingly one to one, and each pair of elements is arranged for measurement of the distance of only one of the subjects which are located in different directions.

When the triangulation method is used to perform distance measurement in a region near to the camera,

known as a near region or "macro" region, since the angle of reflection of the reflected light which has impinged on the subject becomes large, the reflected light extends outside the light-receiving element. Therefore, it is difficult for the known multi AF type cameras to perform photography in the "macro" region.

It is an object of the present invention to provide a range meter for multi AF type cameras which can readily perform distance measurement even when a subject to be photographed is present in the near or "macro" region.

According to the present invention, there is provided a range meter for a camera comprising light-projecting means for projecting a plurality of irradiation beams in different directions; a plurality of light-receiving elements each of which is arranged to receive reflected light from a subject which has been irradiated by a said irradiation beam, each light-receiving element being arranged to provide an output signal corresponding to the position thereon at which the said reflected light is received; arithmetic means for calculating from a said output signal or signals the distance to a desired subject; and means for varying or selecting the said output signals which are transmitted to the arithmetic means in dependence upon the distance of the said desired subject from the meter.

In one embodiment, the means for varying or selecting the said output signals comprises a changeover means for changing the relationship between the irradiation beams and the light-receiving elements. Thus the changeover means may be such that, when the desired subject is located at above a predetermined minimum range, the reflected light which is received by each light-receiving element is derived from one particular

respective light-projecting element and when the desired subject is located below the predetermined minimum range, the reflected light which is received by each light-receiving element is derived from a different light-projecting element.

In a second embodiment, the means for varying or selecting the said output signals comprises determination means for determining which of the light-receiving elements has received the said reflected light from the subject, the determination means being connected to the arithmetic means so that the latter is controlled only by the last-mentioned light-receiving element.

The invention also comprises a range meter for a camera comprising light-projecting means for projecting a plurality of irradiation beams in different directions; a plurality of light-receiving elements each of which is arranged to receive reflected light from a subject which has been irradiated by a said irradiation beam, each light-receiving element being arranged to provide an output signal corresponding to the position thereon at which the said reflected light is received in a longitudinal direction; arithmetic means for calculating from a said output signal or signals the distance to a desired subject; and changeover means for changing the relationship between the irradiation beams and the light-receiving elements.

The invention further comprises a range meter for a camera comprising light-projecting means for projecting a plurality of irradiation beams in different directions; a plurality of light-receiving elements each of which is arranged to receive reflected light from a subject which has been irradiated by a said irradiation beam, each light-receiving element being arranged to

provide an output signal corresponding to the position thereon at which the said reflected light is received in a longitudinal direction; arithmetic means for calculating from a said output signal or signals the distance to a desired subject; and determination means for determining which of the light-receiving elements has received the said reflected light from the subject.

Additionally, the invention comprises a camera provided with a range meter as set forth above.

The invention is illustrated, merely by way of example, in the accompanying drawings, in which:-

Figure 1 is a block diagram showing a first embodiment of the present invention;

Figure 2 is a diagram showing the principle of operation of the first embodiment;

Figure 3 is a flowchart showing the operation of the first embodiment, and

Figure 4 is a block diagram showing a second embodiment of the present invention.

<u>Embodiment 1</u>

Figures 1, 2 and 3 show a first embodiment of the present invention.

As shown in Figure 1, the said first embodiment comprises light-projecting elements IR1, IR2 and IR3 each of which comprises a light emitting diode for emitting far infrared light. The light projecting elements IR1, IR2 and IR3 are arranged in a row in front of a camera (not shown). LS1 is a light-projecting lens for projecting the light ~~from each of the light~~ from each of the light-projecting elements IR1, IR2 and IR3 to form corresponding irradiation beams travelling in different directions.

The light-projecting elements IR1, IR2 and IR3 and the light-projecting lens LS1 together constitute a

light-projecting means.

EM is a light-projecting circuit for causing the light-projecting elements IR1, IR2 and IR3 to emit light in a time sharing manner.

PT1, PT2 and PT3 are light-receiving elements each of which comprises a plurality of photodiodes. Each of the light-receiving elements PT1, PT2 and PT3 receives the reflected light from one of subjects SB1, SB2 and SB3 which are capable of being photographed so as to provide an output signal corresponding to the position on the respective light-receiving element in the longitudinal direction thereof of the light received from the respective subject. The light-receiving elements PT1, PT2 and PT3 are arranged in a row in front of the camera and correspond one to one to the light-projecting elements IR1, IR2 and IR3 in relation to general distance measurement.

LS2 is a light-receiving lens for focusing the reflected light from each of the subjects onto the light receiving elements PT1, PT2 and PT3.

CH is a changeover circuit acting as a changeover means, which, upon receipt of a control signal from a main control circuit CR described later, changes the relationship between the light-projecting elements IR1, IR2 and IR3 and the light-receiving elements PT1, PT2 and PT3. In the case of normal distance measurement, i.e. when the subject to be photographed is located beyond the "macro" region, the relationship between the light-projecting elements IR1, IR2 and IR3 and the light-receiving elements PT1, PT2 and PT3 is such that IR1 corresponds to PT1, IR2 to PT2 and IR3 to PT3. That is, in the case of normal distance measurement, the light-receiving element PT1, PT2 or PT3 is selected in response to the light emission timing of the light-

projecting element IR1, IR2 or IR3, respectively.

DT1 and DT2 are detecting circuits for detecting the output signals of the light receiving element PT1, PT2 or PT3 as selected by the changeover circuit CH.

CP is a comparison circuit which provides an output when the output signal of the light-receiving element PT1, PT2 or PT3 that is detected by the detecting circuit DT2 exceeds a preset reference value. Although the embodiment performs comparison on the basis of the output signal from one detecting circuit, comparison may be performed on the basis of the output signals of the two detecting circuits.

OP is an arithmetic circuit which provides an output signal corresponding to the distance to a subject to be photographed on the basis of the output signal of the detecting circuits DT1 and DT2.

AD is an A/D (analog to digital) converting circuit for converting the output signal of the arithmetic circuit OP from analog to digital form so as to provide a range value.

MR is a storage circuit comprising a ROM (read-only memory). The storage circuit MR holds conversion coefficients used in converting the range value produced by the A/D converting circuit AD into a real distance value. Different sets of conversion coefficients are prepared depending on the relationship between the light-projecting elements IR1, IR2 and IR3 and the light-receiving elements PT1, PT2 and PT3.

CR is a main control circuit for controlling the whole system.

LC is a lens control circuit for controlling the position of the lens of the camera in response to the distance information from the main control circuit CR.

The principle of operation of the first embodiment

will be described with reference to Figure 2.

When there is a certain distance between the camera and the subjects SB11, SB22 and SB33 which are to be photographed, e.g. when the subjects to be photographed are disposed outside the "macro" region, the irradiation beams projected from the light-projecting elements IR1, IR2 and IR3 toward the subjects can be received by the light-receiving elements PT1, PT2 and PT3, respectively. On the other hand, when the subjects SB12 and SB23 which are to be photographed are present in the "macro" region, the angle of reflection r12, r23, becomes large. Consequently, the irradiation beam projected from the light-projecting element IR1 towards the subject SB12, for example, cannot be received by the light receiving element PT1. In such a case, the irradiation beam projected from the light-projecting element IR1 towards the subject SB12 is received by the light-receiving element PT2, the irradiation beam projected from the light-projecting element IR2 toward the subject SB23 is received by the light-receiving element PT3, and the outputs of these light-receiving elements are processed. When a subject SB13 is present in a very short distance (in a "very macro" region), the irradiation beam projected from the light-projecting element IR1 toward the subject SB13 is received by the light-receiving element PT3, and the output of this light-receiving element is processed.

The operation of the first embodiment will be described with reference to the flow chart of Figure 3.

When a release switch (not shown) of the camera is depressed, a series of operations begins as follows.

[Step (a)].

First, under the control of the changeover circuit CH, the light-receiving element PT1 is selected at the

emission timing of the light-projecting element IR1, the light-receiving element PT2 is selected at the emission timing of the light-projecting element IR2, and the light-receiving element PT3 is selected at the emission timing of the light projecting element IR3 [Step (b)].

The output signal of each of the light-receiving elements PT1, PT2 and PT3 that is detected by the detecting circuit DT2 is compared in the comparison circuit CP with a preset reference value [Step (c)].

When at least one of the output signals of the light-receiving elements PT1, PT2 and PT3 is larger than the reference value, i.e. when the subject is present outside the "macro" region, the following operation is performed. Data processing is performed in the arithmetic circuit OP on the basis of the output signals of the detecting circuits DT1 and DT2. Each calculation result is converted in the A/D converting circuit AD from analog to digital form and then sent to the main control circuit CR as a range value [Step (d)].

In the main control circuit CR, the smallest value among the range data in digital form is chosen and is used as a distance value. [Step (e)]. The lens control circuit LC controls the position of the lens of the cameras on the basis of the distance value outputted from the main control circuit CR.

When all of the output signals of the light-receiving elements PT1, PT2 and PT3 are smaller than the reference value held in the comparison circuit CP [Step (c)], the relationship between the light-projecting elements and the light-receiving elements is changed. Consequently, under the control of the changeover circuit CH, the light-receiving element PT2 is selected at the emission timing of the light-projecting element IR1, and the light-receiving element PT3 is selected at

the emission timing of the light projecting element IR2 [Step (g)]. Each of the output signals of the light-receiving elements PT2 and PT3 that are detected by the detecting circuit DT2 is compared in the comparison circuit CP with the preset reference value [Step (h)].

When either of the output signals of the light-receiving elements PT2 and PT3 is larger than the reference value, i.e. when the subject is disposed in the "macro" region, the following operation is performed. Data processing is performed in the arithmetic circuit OP on the basis of the output signals of the detecting circuits DT1 and DT2. Each calculation result is converted in the A/D converting circuit AD from analog to digital form and then sent to the main control circuit CR as a range value [Step (i)].

In the main control circuit CR, the smaller one among the two range values in digital form is chosen. [Step (j)]. The thus chosen range value is converted into a real distance value on the basis of the conversion data held in the storage circuit MR. The lens control circuit LC controls the position of the lens of the camera on the basis of the distance value outputted from the main control circuit CR [Step (f)].

When both of the output signals of the light-receiving elements PT2 and PT3 are smaller than the reference value held in the comparison circuit CP, [Step (h), the relationship between the light-projecting elements and the light receiving elements is changed. Consequently, under the control of the changeover circuit CH, the light-receiving element PT3 is selected at the emission timing of the light-projecting element IR1. [Step (k)]. The output signal of the light-receiving element PT3 that is detected by the detecting circuit DT2 is compared in the comparison circuit CP

with the preset reference value. [Step (m)].

When the output signal of the light-receiving element PT3 is larger than the reference value, i.e. when the subject to be photographed is present in the "very macro" region, the following operation is performed. Data processing is performed in the arithmetic circuit OP on the basis of the output signals of the detecting circuits DT1 and DT2. The calculation result is converted in the A/D converting circuit AD from analog to digital form and then sent to the main control circuit CR as a range value. [Step (n)]. The range value is converted into a real distance value on the basis of the conversion data held in the storage circuit MR. The lens control circuit LC controls the position of the lens of the camera on the basis of the distance value given from the main control circuit CR.

When the output signal of the light-receiving element PT3 is smaller than the reference value held in the comparing circuit CP [Step (m)], the distance to the subject to be photographed is considered as infinity; thus, infinity is used as the distance value. [Step (p)]. The lens control circuit LC controls the position of the lens of the camera on the basis of the distance value given from the main control circuit CR (f).

In the first embodiment described above, focussing of the camera lens can be effected automatically in a wide range irrespective of whether the subject is positioned remote from the camera or whether it is positioned at a very short distance therefrom.

Embodiment 2

Figure 4 shows a second embodiment of the present invention, whose principle of operation is as described with reference to Figure 2.

Since most components shown in Figure 4 which are

designated by the same reference symbols as used in Figure 1 are identical with those shown in Figure 1, only a few of the components shown in Figure 4, which are designated by new reference symbols, will be described.

DT3, DT4 and DT5 are detecting circuits for detecting the output signals of the light-receiving elements PT1, PT2 and PT3, respectively.

DE is a determination circuit for determining which light-receiving element has received the reflected light from the subject on the basis of the output signals of the detecting circuits DT3, DT4 and DT5.

The operation of the second embodiment will now be described.

When the release switch (not shown) of the camera is depressed, a series of operations begins as follows.

In accordance with the signal from the light-projecting circuit EM, the light-projecting elements IR1, IR2 and IR3 successively emit light in a time-sharing manner. At each emission timing, it is determined which light-receiving element has received the reflected light from the subject. Specifically, a determination is made in the determination circuit DE on the basis of the output signals of the detecting circuits DT3, DT4 and DT5. The determination result is sent to the arithmetic circuit OP. For example, when it is determined that the reflected light from the subject has been received by the light-receiving element PT2, data processing is performed in the arithmetic circuit OP on the basis of the output signal of the corresponding detecting circuit DT4. The calculation result is converted in the A/D converting circuit AD from analog to digital form and is then sent to the main control circuit CR as a range value. In the main

control circuit CR, the smallest value among the range data obtained at each emission timing (three times in the case of the second embodiment) is chosen as the value of the distance to the subject. The lens control circuit LC controls the position of the lens of the camera on the basis of the distance vlaue outputted from the main control circuit CR.

As described above, the second embodiment can focus the camera lens automatically with a reduced number of times of distance measurement (three times in the second embodiment) in a wide range irrespective of whether the subject is positioned remote from the camera or whether it is positioned at a very short distance therefrom.

In the first and second embodiments, "Macro" or "Very Macro", for example, may be displayed in the viewfinder when the subject is determined as positioned in the "macro" region or in the "very macro" region, respectively.

Although the first and second embodiments automatically select the normal region, "macro" region or "very macro" region, the selection of the particular region may be performed by manual switching.

In the embodiments described above, it is possible to change the relationship between the light-projecting means and the light-receiving means or to determine which light-receiving element has received the reflected light from the subject, so that distance measurement in the "macro" region can be readily performed.

CLAIMS

1. A range-meter for a camera comprising light-projecting means for projecting a plurality of irradiation beams in different directions; a plurality of light-receiving elements each of which is arranged to receive reflected light from a subject which has been irradiated by a said irradiation beam, each light-receiving element being arranged to provide an output signal corresponding to the position thereon at which the said reflected light is received in a longitudinal direction; arithmetic means for calculating from a said output signal or signals the distance to a desired subject; and determination means for determining which of the light-receiving elements has received the said reflected light from the subject.

2. A range meter substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

3. A camera provided with a range meter as claimed in any preceding claim.

4. A range meter for cameras comprising light projecting means for projecting a plurality of irradiation beams in different directions, a plurality of light receiving elements each for receiving the reflected light from a subject of shooting irradiated with the irradiation beam to provide an output signal corresponding to a light-received point in its longitudinal direction, and arithmetic means for calculating the distance to the subject on the basis of the output signal of the light receiving element, characterized by determining means for determining which one out of the plurality of light receiving elements has received the reflected light from the subject irradiated with the irradiation beam.

Patents Act 1977
Examiner's report to the Comptroller under Section 17
(The Search report)

Application number
GB 9401140.0

Relevant Technical Fields

(i) UK Cl (Ed.M) H4D (DLAT, DLAV, DLRA)

(ii) Int Cl (Ed.5) GO1C (3/06, 3/08); GO15 (17/02, 17/08, 17/32, 17/88; G93B (13/18, 13/20)

Databases (see below)
(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

(ii)

Search Examiner
B G WESTERN

Date of completion of Search
7 APRIL 1994

Documents considered relevant following a search in respect of Claims :-
1-4

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages	Relevant to claim(s)
A	GB 2239760 A (SEIKOSHA) see whole document	
A	GB 2219709 A (SEIKOSHA) see whole document	

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